

A new approach to crystal silicon thin films on glass

Goal: c-Si on glass

- Material quality of crystal silicon
- Economics of thin films

Chaz Teplin, Howard Branz,
David Ginley, Eugene Iwaniczko,
Kim Jones, Mowafak Al-Jassim,
Dean Levi, Matthew Dabney, Paul
Stradins, Maikel van Hest, John
Perkins, Phil Parilla, Bobby To,
Bob Ready, Matt Page, Helio
Moutino, Tapas Chaudhuri



NREL National Renewable Energy Laboratory

*A national laboratory of the U.S. Department of Energy
Office of Energy Efficiency & Renewable Energy*

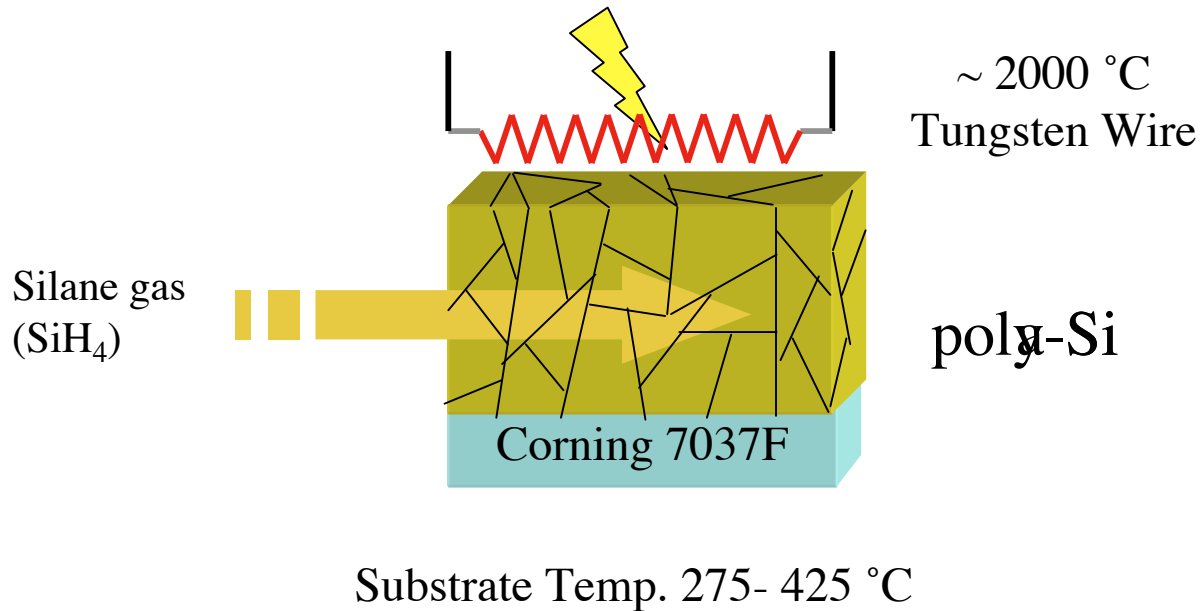
Innovation for Our Energy Future

Another approach to thin film silicon

Goal: Silicon on glass

- Quality of crystal silicon
- Economics of thin films

It's “easy” to make bad thin film c-Si

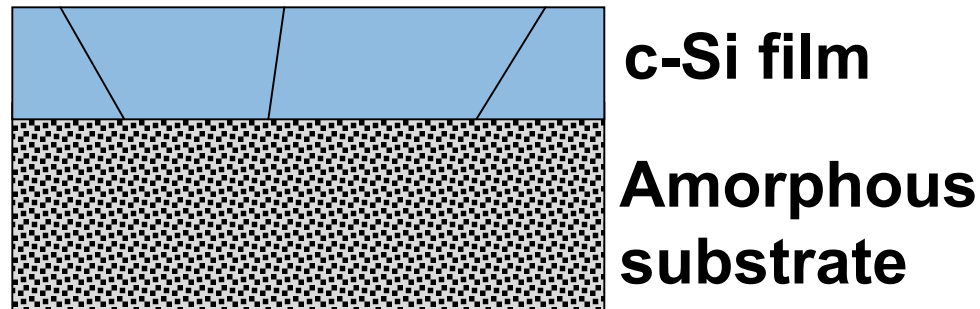


Results in Poor Material

- Small grains
- Random grain orientation (polycrystalline)

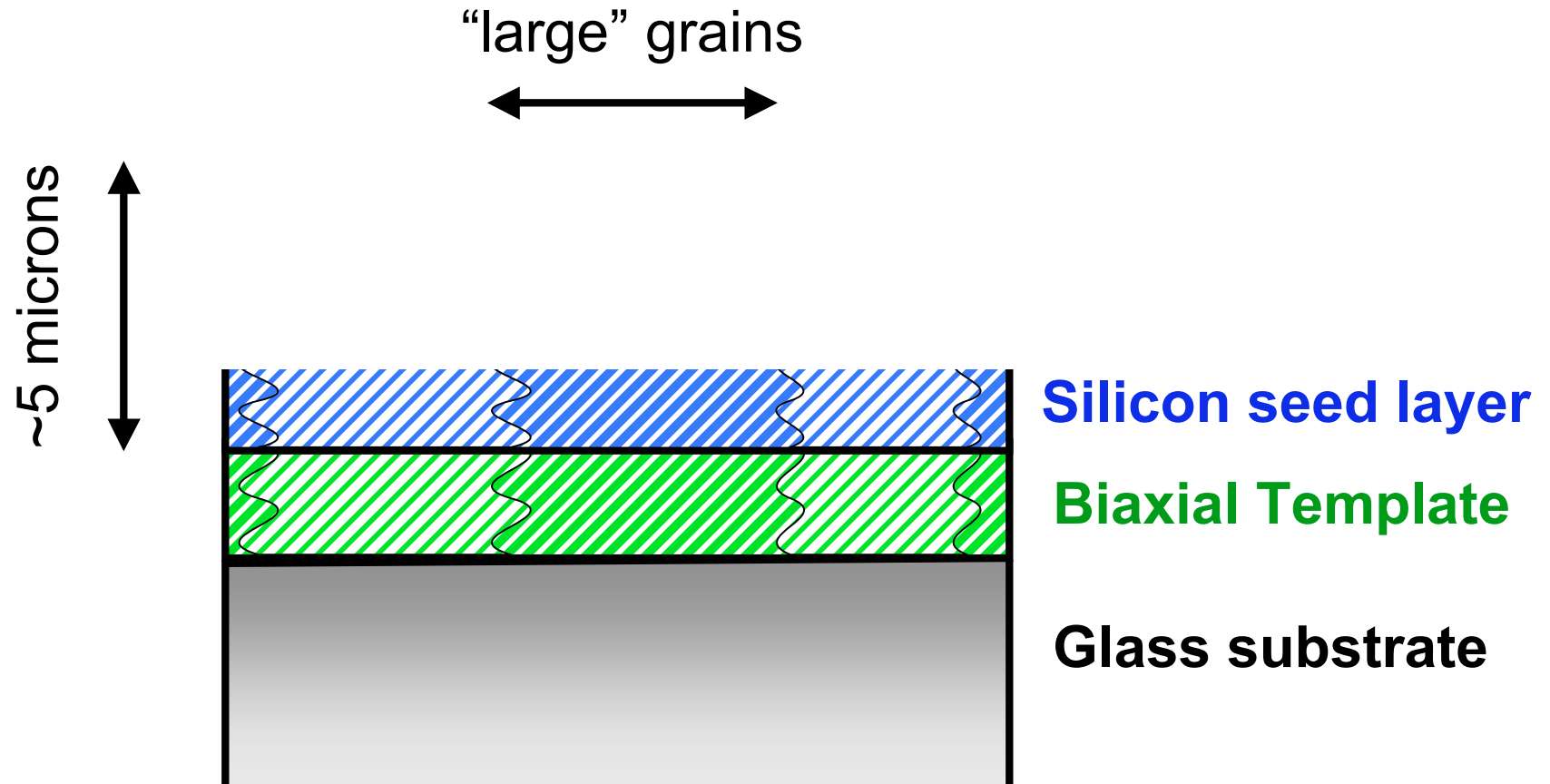
Desired c-Si film properties

- Large grains
- Uniformly oriented grains (biaxial texture)
 - Passivated grain boundaries



**The crucial challenge:
Substrate/c-Si interface**

Proposed route to c-Si on glass



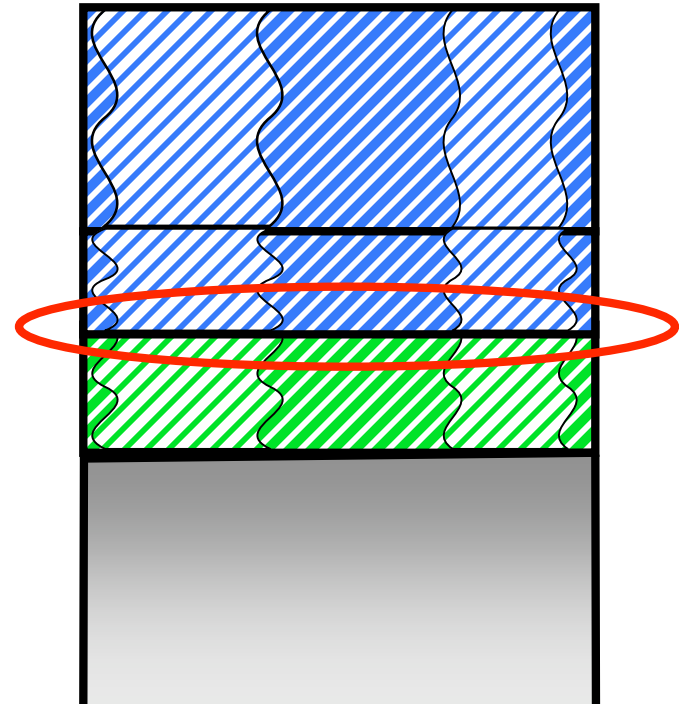
The template/c-Si interface

Goal

Attain a silicon seed layer
with biaxial texturing

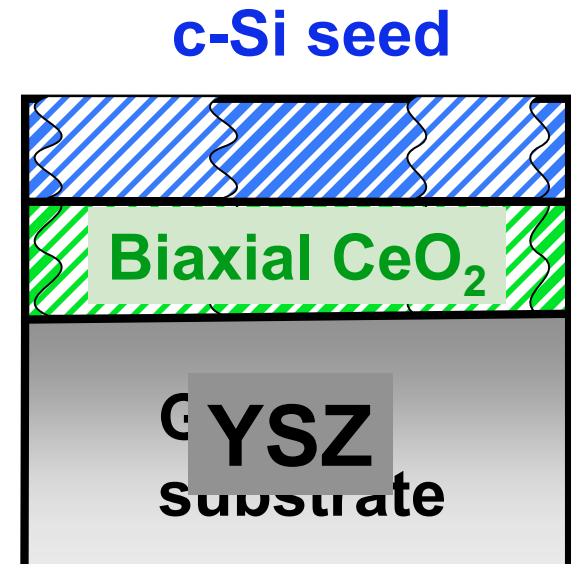
Potential template materials

CeO₂, NiSi, CoSi, ZrO₂, TiN



First template: CeO_2

- ✓ Lattice matched to silicon
- ✓ Safe, abundant, stable material
- ✓ Has been grown with biaxial texture on glass
- ✗ Not conductive
 - Eliminates some device structures

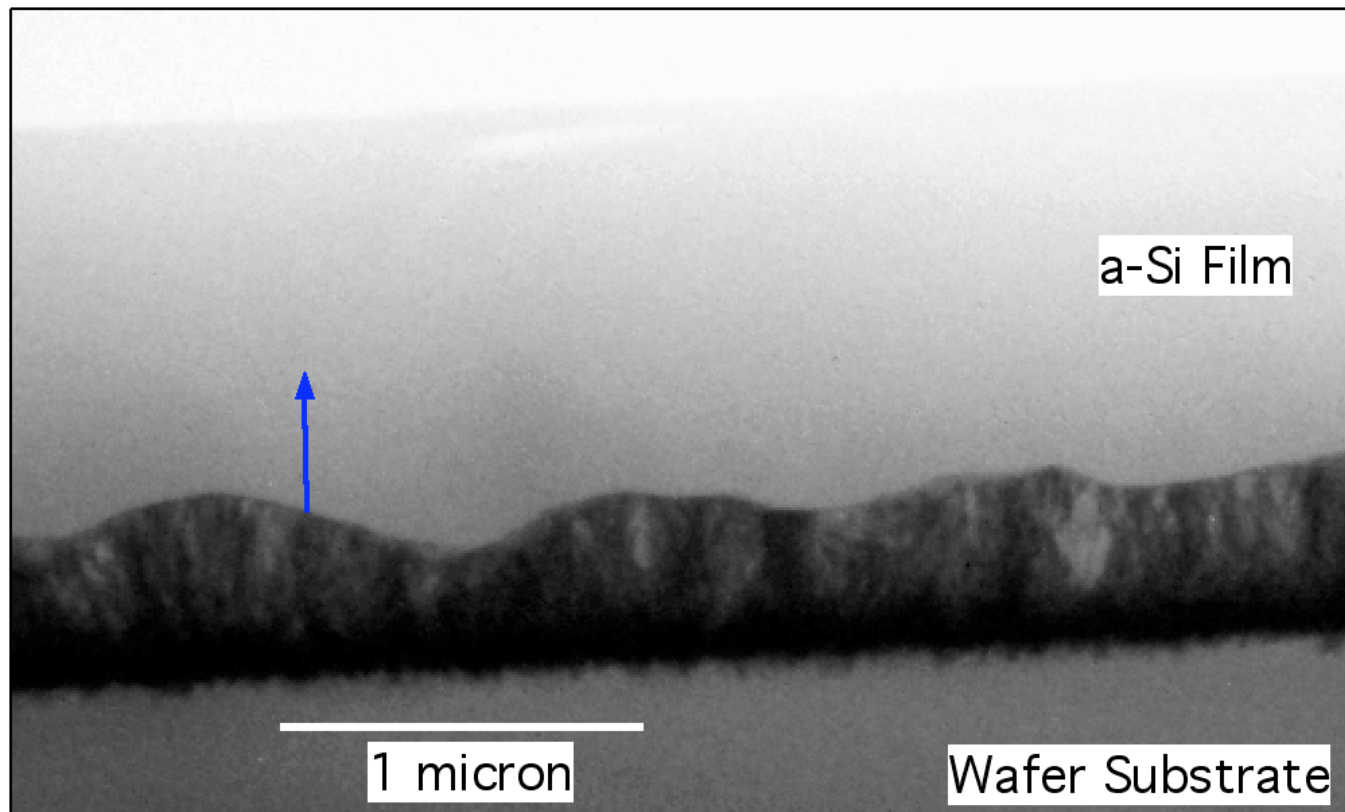


Initial experiments: Start with CeO_2 grown on single crystal YSZ substrates.

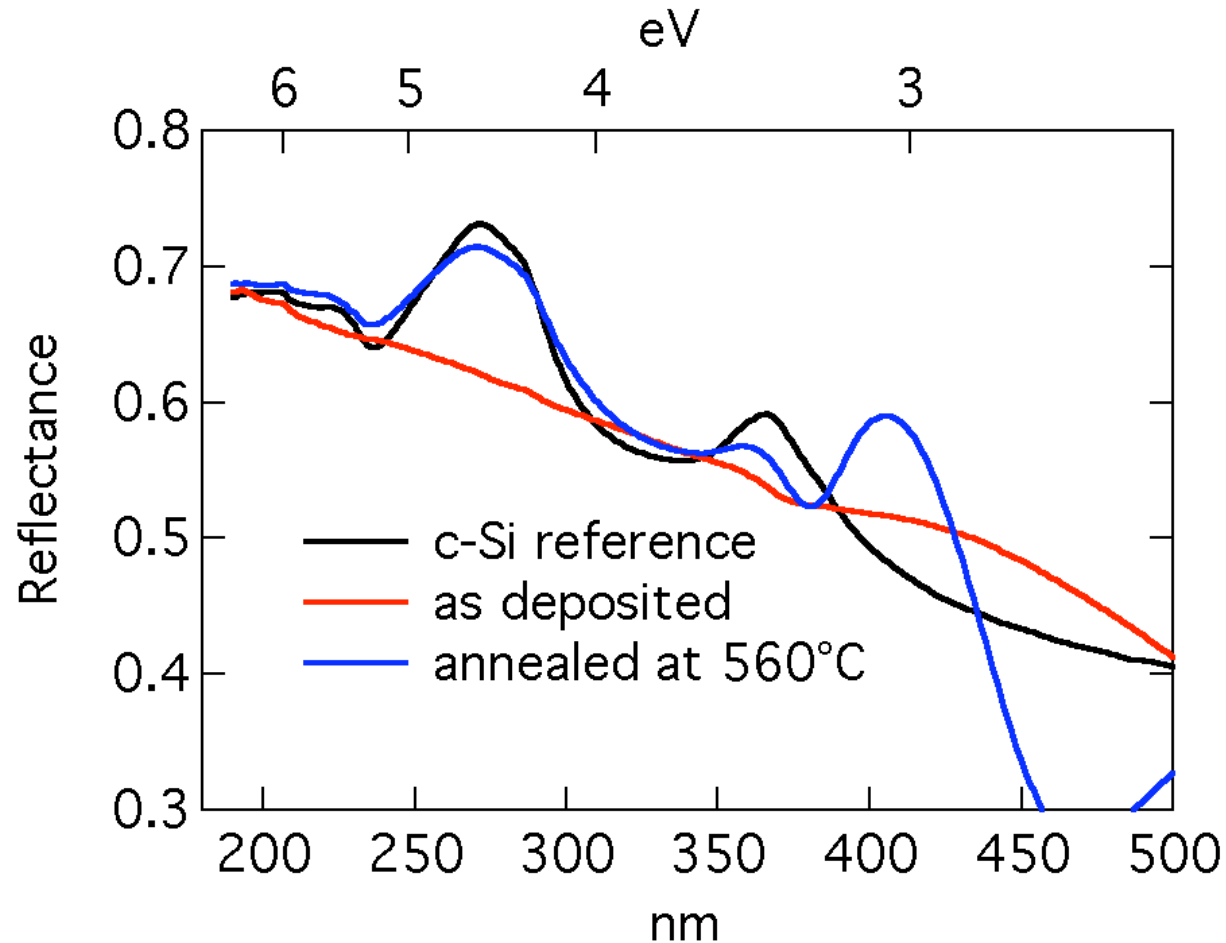
Our goal is to study the CeO_2/Si interface

Solid phase epitaxy demonstrated on wafers

- Direct epitaxial growth
- Solid phase epitaxy: annealing an amorphous film

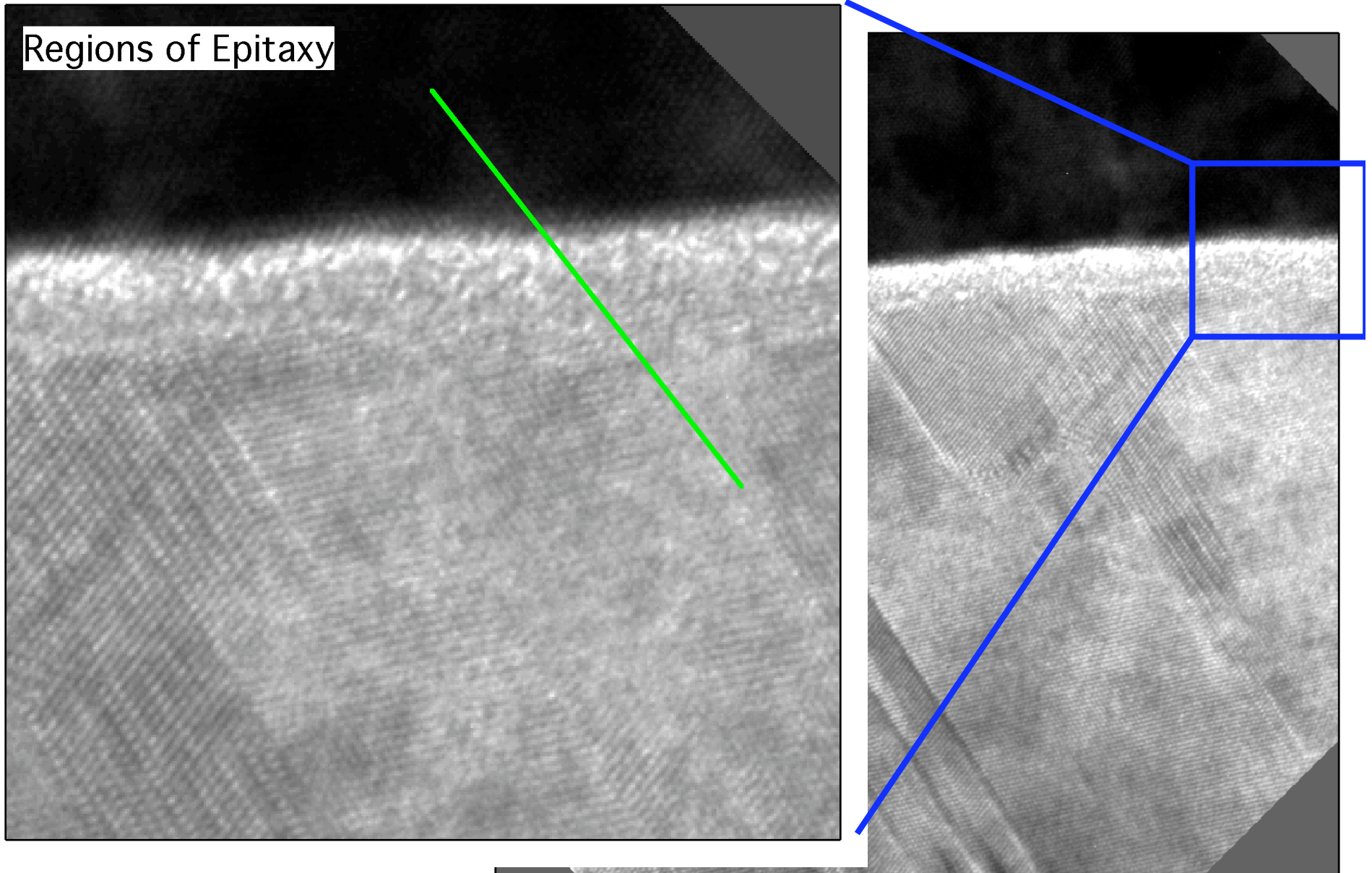


As-deposited, the bulk of silicon films deposited on YSZ/CeO₂ are a-Si:H



After annealing, the film is crystalline ...

TEM very encouraging



Template approach to c-Si on glass

A work in progress

Next Steps

1. How much epitaxy is possible?
2. SiO_x formation
3. HWCVD deposition conditions
4. Do we need direct growth heteroepitaxy?
5. Grow CeO_2 on glass

